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A Computer Program for Counting Load Spectrum Cycles

based on the

Range Pair Cycle Counting Method

V. A. Tischler

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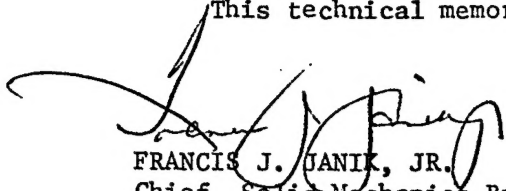
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FOREWORD

This report was prepared by V.A. Tischler of the Solid Mechanics Branch, Structures Division, Air Force Flight Dynamics Laboratory. The work was conducted in-house under Project 1467, "Structural Analysis Methods," Task 146702, "Analysis Methods for Damaged Structures". Mr. Howard A. Wood is the Project Engineer.

The manuscript was released by the author in November 1972.

This technical memorandum has been reviewed and is approved.



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Chief, Solid Mechanics Branch
Structures Division

ABSTRACT

This report presents a detailed description of a computer program based on the Range Pair Cycle Counting Method, as given in Reference 3. The Range Pair Cycle Counting Method is a procedure for generating an analysis spectrum from a given load spectrum. Examples are presented where the resulting analysis spectrum will be used as input to a crack growth analysis program.

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SECTION I

INTRODUCTION

In crack propagation analysis it is necessary to have a correct representation of the load spectrum. A load spectrum obtained from tests may not be directly applicable to analysis. The Range Pair Cycle Counting Method is a means of determining an accurate analysis spectrum from the actual load spectrum. This method is briefly discussed and compared with other counting methods in References 1 and 2. A more comprehensive discussion which forms the basis for the development of the present computer program is given in Reference 3.

The computer program treats a load spectrum S as a collection of n peaks and valleys designated by x_i , $i = 1, \dots, 2n$, such that if x_i is a peak then x_{i+1} is a valley, $1 \leq i \leq 2n-1$. The analysis spectrum is represented by a collection of m cycles $\{(a, b)_i\}$, $i = 1, \dots, m$, such that a_i and b_i are elements of S . The Range Pair Cycle Counting Method considers four points (x_1, x_2, x_3, x_4) at a time and the conditions for counting a cycle (x_2, x_3) are as follows:

If $x_2 > x_1$, then a cycle is counted if

$$x_2 \leq x_4 \text{ and } x_3 \geq x_1.$$

Conversely, if $x_2 < x_1$, then a cycle is counted if

$$x_2 \geq x_4 \text{ and } x_3 \leq x_1.$$

This method is illustrated in Figure 1.

Thus, starting at the beginning of the load spectrum the first four points x_1, x_2, x_3 and x_4 are considered. If x_2 and x_3 meet the above conditions, a cycle is defined and these two points are deleted from the spectrum. Consequently x_4 becomes x_2 and the next two points of the spectrum are added to again give four points. Counting continues until the four points considered do not define a cycle. Then x_1 is omitted from consideration and becomes an element of a residue spectrum. The three remaining points are updated, i.e. x_2 becomes x_1 , x_3 becomes x_2 , x_4 becomes x_3 , and x_4 is added sequentially from the load spectrum. This process continues until there are only two or three points remaining. These points are added to the residue spectrum, which is then analyzed in the same manner as the original load spectrum. Continuing in this manner a residue spectrum is

finally generated which will yield no cycles by the Range Pair Cycle Counting Method. This residue spectrum diverges to a maximum range and then converges as shown in Figure 2. Cycles are generated from the final residue spectrum as follows: Pair the highest peak with the lowest valley to form a cycle. Then moving away from this cycle in both directions, each successive peak and valley are paired together. If there is an extra peak or valley left on either side, it is omitted. This counting method is illustrated in Figure 2.

In summary, an original load spectrum is analyzed using the Range Pair Cycle Counting Method to produce an analysis spectrum plus a final residue spectrum. This final residue spectrum is then analyzed by a pairing technique to determine the remaining cycles, which are then added to those previously counted. The result is a complete analysis spectrum for use in analytical predictions.

SECTION II

PROGRAM ORGANIZATION

The Range Pair Cycle Counting program, RPCM, assumes that the input load spectrum, S , is defined by n peaks and valleys, (x_i, y_i) , and n counters k_i , $i=1, \dots, n$, where k_i is a count of the number of times the i th peak and valley are to be repeated sequentially. The program then assigns a step number j , $j=1, \dots, n$ to each peak and valley of S . Since the analysis spectrum is generated in disjoint parts, i.e. from the input load spectrum, from each residue spectrum, and from the final residue spectrum, the step numbers are used to sort the analysis spectrum relative to the sequencing of the initial load spectrum. Sequence becomes important particularly in crack growth analysis. When the counter k is less than 1, as can occur in a flight by flight load spectrum, the peak and valley associated with k is not analyzed by the program, but is transferred directly into the analysis spectrum and subsequently sequenced relative to its step number.

The program RPCM is divided into three parts. Each part is described below in a step-by-step manner.

Part I

1. The initial load spectrum S is adjusted by removing those peaks and valleys whose counter k is less than one.
2. The initial load spectrum S is further adjusted if for some i , the i th peak and valley are equal to the $(i+1)$ th peak and valley, by maximizing the counter k_i .
3. The Range Pair Cycle Counting Method is now applied to the adjusted load spectrum, S . Program RPCM calls Subroutine DECIDE with four elements from S . Subroutine DECIDE determines whether a cycle is to be generated or whether x_1 goes to the residue spectrum. Cycles are generated in Subroutine CYCGEN.

Part II

1. The Range Pair Cycle Counting Method is applied to the residue spectrum. Program RPCM calls Subroutine DECRES with four elements from the residue spectrum. Subroutine DECRES determines whether a cycle is to be generated or whether x_1 goes to the next residue spectrum. Cycles are generated in Subroutine CYCRES.

2. If the current residue spectrum has less than three points or if no additional cycles can be generated by the Range Pair Cycle Counting Method, proceed to Part III, otherwise return to Step 1.

Part III

1. The remaining cycles are generated from the final residue spectrum.

2. The analysis spectrum is sorted relative to the sequencing of the input load spectrum.

SECTION III

INPUT INSTRUCTIONS

<u>Card No.</u> (Format)	<u>Variable Name</u>	<u>Definition</u>
1 (8A10)	TITLE	An alphanumeric description of the load spectrum, S
2 (2I5)	NPKS	Number of peaks or valleys in the load spectrum, S
	NPUNCH	Punch flag NPUNCH \neq 0 implies the analysis spectrum will be punched in the input format.
3,...,NPKS+2 (5x,3E10.3)	SIGMAX(I)	Ith peak of the load spectrum, S
	SIGMIN(I)	Ith valley of the load spectrum, S
	RNCYC(I)	counter k_i of the Ith peak and valley

SECTION IV
TABULAR OUTPUT

Program RPCM gives the following output:

1. The input load spectrum, S.
2. The adjusted load spectrum as discussed in Section II.
3. The elements and step numbers of Residue Spectrum 1.
4. The elements, the step number and the counter k of the cycles generated from the adjusted load spectrum.
5. The elements and step numbers of Residue Spectrum 2.
6. Step 4 output is repeated plus any additional cycle information generated from Residue Spectrum 1.
7. Steps 5 and 6 are repeated for each residue spectrum until the final residue spectrum is generated.
8. All previous cycle output plus any additional cycle information generated from the final residue spectrum.
9. The Range Pair Cycle Counted spectrum, i.e., the analysis spectrum.

REFERENCES

1. J.B. de Jonge, "The Monitoring of Fatigue Loads," National Aerospace Laboratory NLR, The Netherlands, Report MP 70010 U.
2. N.E. Dowling, "Fatigue Failure Predictions for Complicated Stress - Strain Histories", University of Illinois, Urbana, T.&A.M., Report No. 337, January 1971.
3. S. Streitmatter, "A Method of Counting Spectrum Load Cycles", North American Rockwell, Los Angeles Division, TFD-72-358, March 1972.

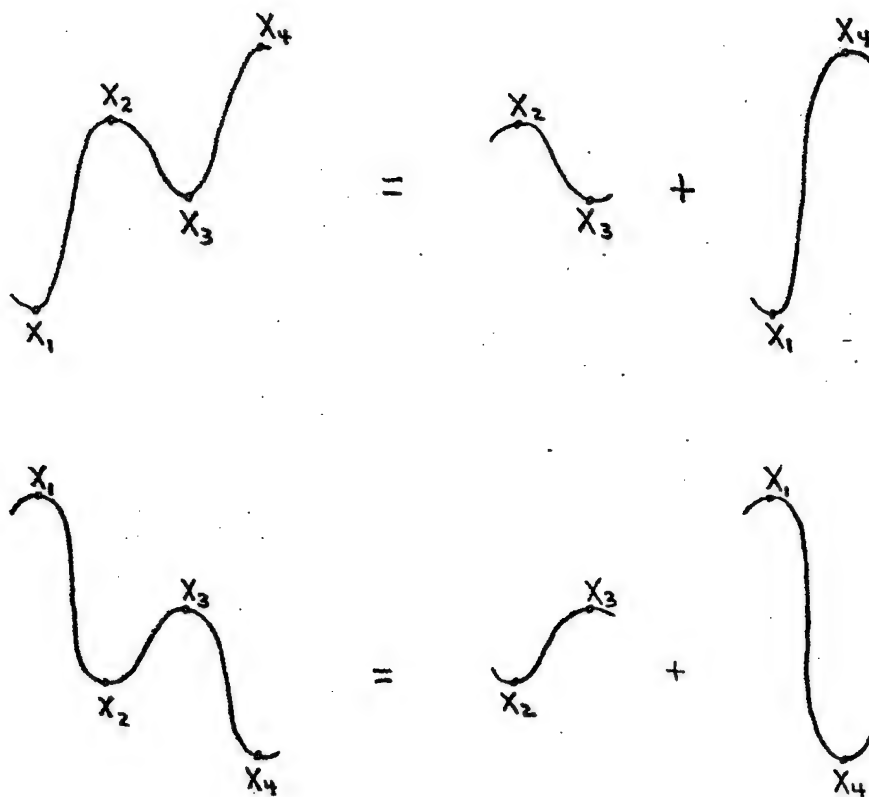


Figure 1

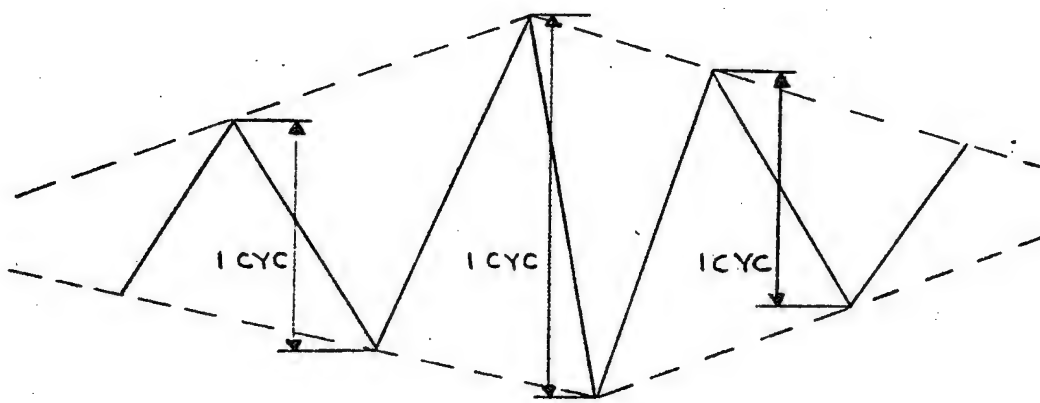


Figure 2

PARTIAL SCHEMATIC OF THE 14 MISSION C5-A A SPECTRUM

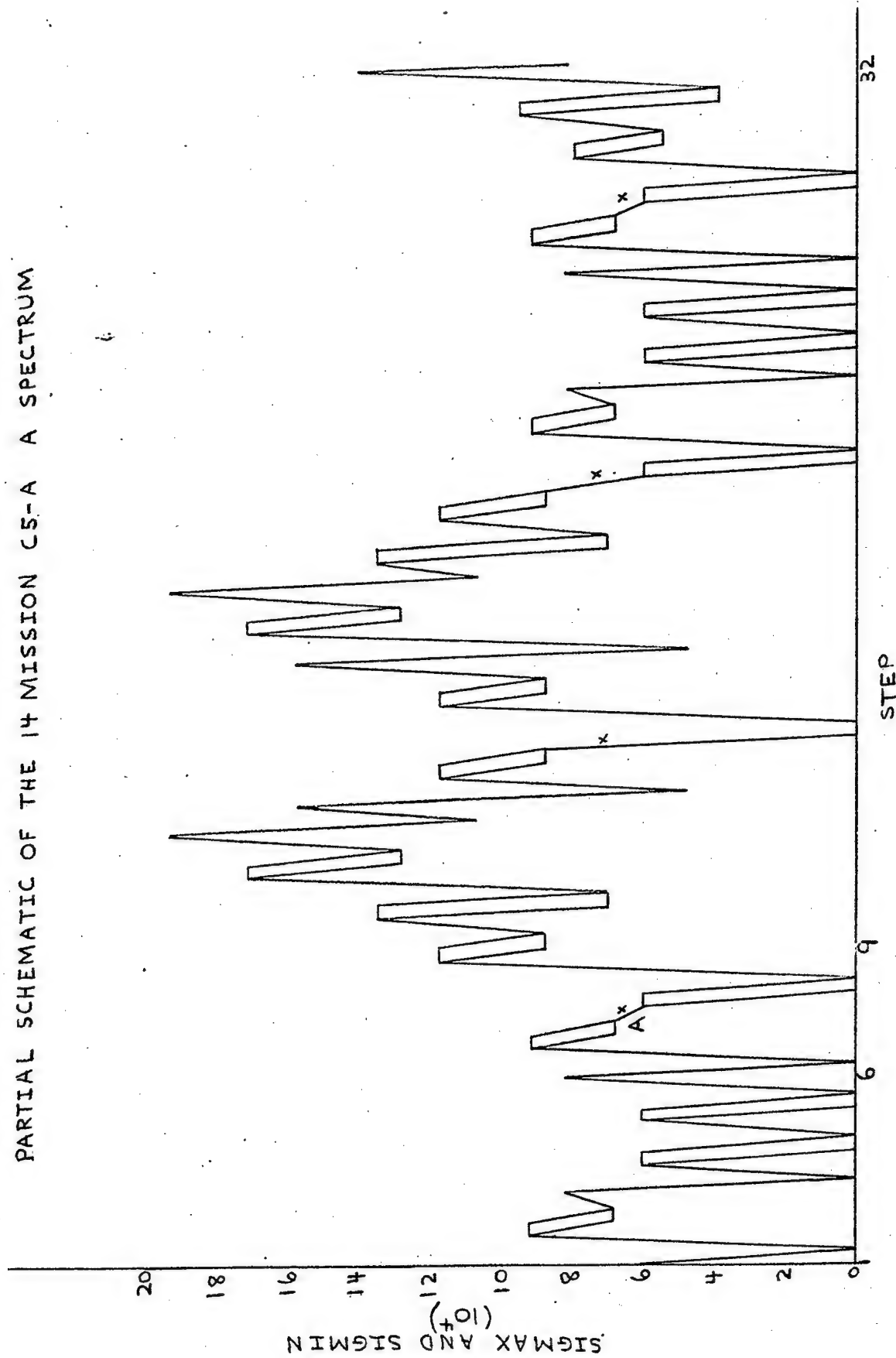


Figure 3

AN EXPANDED VIEW ABOUT
THE POINT A OF THE
LOAD SPECTRUM IN FIGURE 3

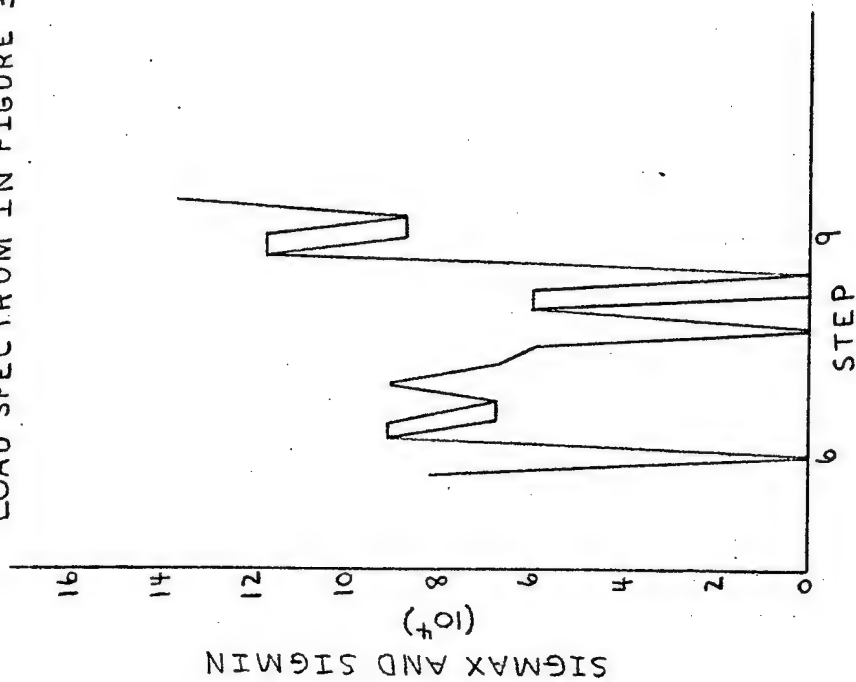


Figure 4

APPENDIX 1
SAMPLE PROBLEMS

1. 14 Mission C5-A A Spectrum

A partial plot of the input load spectrum S is given in Figure 3. The full spectrum is listed on P . It has been observed that the spectrum listing may not be a good representation of the load spectrum since some of the peaks or valley values given in the spectrum listing do not match the actual peaks and valleys on the load spectrum. This can be illustrated by steps 6 through 9 of the spectrum listing.

6	8215.0	0.0	1
7	9146.0	6846.0	5
8	6065.0	0.0	12
9	11790.0	8790.0	50

The load spectrum that these 4 steps would produce is given in Figure 4. Now considering the actual peaks and valleys shown in Figure 4, steps 6 through 9 should become

8215.0	0.0	1
9146.0	6846.0	4
9146.0	0.0	1
6065.0	0.0	11
11790.0	8790.0	50

These five steps may now be range pair counted according to the rules given. The x's on Figure 3 indicate additional places where the above type of behaviour occurs.

The program as written can handle such discrepancies in the initial load spectrum.

14 MISSION C5-A A SPECTRUM

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14	0.	0.	12.00000
2	.914630E+14	0.	.684600E+04	5.00000
3	.821590E+14	0.	0.	1.00000
4	.606500E+14	0.	0.	12.00000
5	.606500E+14	0.	0.	12.00000
6	.821500E+14	0.	0.	1.00000
7	.914600E+14	0.	.684600E+04	5.00000
8	.606500E+14	0.	0.	12.00000
9	.117900E+15	0.	.879330E+04	50.00000
10	.135400E+05	0.	.704000E+04	29.00000
11	.172000E+15	0.	.129000E+05	14.00000
12	.194000E+15	0.	.117330E+05	1.00000
13	.157900E+15	0.	.479900E+04	1.00000
14	.117900E+15	0.	.879330E+04	50.00000
15	.100000E+11	0.	0.	1.00000
16	.117900E+15	0.	.879000E+04	50.00000
17	.157900E+05	0.	.479000E+04	1.00000
18	.172000E+15	0.	.129000E+05	14.00000
19	.194000E+15	0.	.117330E+05	1.00000
20	.135400E+05	0.	.704000E+04	29.00000
21	.117900E+15	0.	.879000E+04	50.00000
22	.606500E+14	0.	0.	12.00000
23	.914600E+14	0.	.684600E+04	5.00000
24	.821500E+14	0.	0.	1.00000
25	.606500E+14	0.	0.	12.00000
26	.606500E+14	0.	0.	12.00000
27	.821500E+04	0.	0.	1.00000
28	.914600E+14	0.	.684600E+04	5.00000
29	.606500E+14	0.	0.	12.00000
30	.794700E+04	0.	.544700E+04	12.00000
31	.949700E+14	0.	.389700E+04	50.00000
32	.140000E+15	0.	.810000E+04	24.00000
33	.122500E+15	0.	.985000E+04	1.00000
34	.113970E+15	0.	.199700E+04	50.00000
35	.794700E+14	0.	.544700E+04	12.00000
36	.606500E+14	0.	0.	5.00000
37	.914600E+04	0.	.684600E+04	1.00000
38	.821500E+14	0.	0.	12.00000
39	.606500E+14	0.	0.	12.00000
40	.606500E+04	0.	0.	1.00000
41	.821500E+14	0.	0.	5.00000
42	.914600E+14	0.	.684600E+04	12.00000
43	.606500E+14	0.	0.	50.00000
44	.794700E+14	0.	.544700E+04	1.00000
45	.113970E+15	0.	.199700E+04	24.00000
46	.122500E+15	0.	.985000E+04	1.00000
47	.140000E+05	0.	.810000E+04	24.00000
48	.949700E+14	0.	.389700E+04	50.00000
49	.794700E+14	0.	.544700E+04	12.00000
50	.606500E+04	0.	0.	5.00000
51	.914600E+14	0.	.684600E+04	1.00000
52	.821500E+14	0.	0.	12.00000
53	.606500E+14	0.	0.	12.00000
54	.606500E+14	0.	0.	12.00000

55	.821500E+J4	0.	1.00000
56	.914600E+J4	0.	5.00000
57	.606500E+04	0.	12.00000
58	.117900E+J5	.879000E+04	50.00000
59	.135400E+J5	.704000E+04	29.00000
60	.172000E+05	.129000E+05	14.00000
61	.194000E+J5	.107000E+05	1.00000
62	.157900E+J5	.879000E+04	1.00000
63	.117900E+J5	.879000E+04	50.00000
64	.100000E+J1	0.	1.00000
65	.117900E+J5	.879000E+J4	50.00000
66	.157900E+J5	.879000E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
68	.194000E+J5	.107000E+05	1.00000
69	.135400E+J5	.704000E+04	29.00000
70	.117900E+05	.879000E+04	50.00000
71	.606500E+J4	0.	12.00000
72	.914600E+J4	.684600E+04	5.00000
73	.821500E+J4	0.	1.00000
74	.606500E+J4	0.	12.00000
75	.606500E+J4	0.	12.00000
76	.821500E+J4	0.	1.00000
77	.914600E+J4	.684600E+04	5.00000
78	.606500E+J4	0.	12.00000

STEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OCCUR CONSECUTIVELY IN THE LOAD SPECTRUM

5 26 40 54 75

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+04		0.	12.00000
2	.914600E+04		.684600E+04	5.00000
3	.821500E+04		0.	1.00000
4	.606500E+04		0.	24.00000
5	.821500E+04		0.	1.00000
6	.914600E+04		.684600E+04	5.00000
7	.606500E+04		0.	12.00000
8	.117900E+05		.879000E+04	50.00000
9	.135400E+05		.704000E+04	29.00000
10	.172000E+05		.129000E+05	14.00000
11	.194000E+05		.107000E+05	1.00000
12	.157900E+05		.479000E+04	1.00000
13	.117900E+05		.879000E+04	50.00000
14	.100000E+05		0.	1.00000
15	.117900E+05		.879000E+04	50.00000
16	.157900E+05		.479000E+04	1.00000
17	.172000E+05		.129000E+05	14.00000
18	.194000E+05		.107000E+05	1.00000
19	.135400E+05		.704000E+04	29.00000
20	.117900E+05		.879000E+04	50.00000
21	.606500E+04		0.	12.00000
22	.914600E+04		.684600E+04	5.00000
23	.821500E+04		0.	1.00000
24	.606500E+04		0.	24.00000
25	.821500E+04		0.	1.00000
26	.914600E+04		.684600E+04	5.00000
27	.606500E+04		0.	12.00000
28	.117900E+05		.879000E+04	50.00000
29	.135400E+05		.704000E+04	29.00000
30	.172000E+05		.129000E+05	14.00000
31	.194000E+05		.107000E+05	1.00000
32	.157900E+05		.479000E+04	1.00000
33	.117900E+05		.879000E+04	50.00000
34	.100000E+05		0.	1.00000
35	.117900E+05		.879000E+04	50.00000
36	.157900E+05		.479000E+04	1.00000
37	.172000E+05		.129000E+05	14.00000
38	.194000E+05		.107000E+05	1.00000
39	.135400E+05		.704000E+04	29.00000
40	.117900E+05		.879000E+04	50.00000
41	.606500E+04		0.	12.00000
42	.914600E+04		.684600E+04	5.00000
43	.821500E+04		0.	1.00000
44	.606500E+04		0.	24.00000
45	.821500E+04		0.	1.00000
46	.914600E+04		.684600E+04	5.00000
47	.606500E+04		0.	12.00000
48	.117900E+05		.879000E+04	50.00000
49	.135400E+05		.704000E+04	29.00000
50	.172000E+05		.129000E+05	14.00000
51	.194000E+05		.107000E+05	1.00000
52	.157900E+05		.479000E+04	1.00000
53	.117900E+05		.879000E+04	50.00000
54	.100000E+05		0.	1.00000
55	.117900E+05		.879000E+04	50.00000
56	.157900E+05		.479000E+04	1.00000
57	.172000E+05		.129000E+05	14.00000
58	.194000E+05		.107000E+05	1.00000
59	.135400E+05		.704000E+04	29.00000
60	.117900E+05		.879000E+04	50.00000

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.194000E+15
.157900E+15
.117900E+15
.100000E+11
.117900E+05
.157900E+15
.172000E+15
.194000E+15
.135400E+15
.117900E+15
.606500E+14
.914600E+14
.821500E+14
.606500E+14
.821500E+04
.914600E+14
.606500E+14

.107000E+05
.479000E+04
.879000E+04
0.
.879000E+04
.479000E+04
.129000E+05
.107000E+05
.704000E+04
.879000E+04
0.
.684600E+04
0.
0.
0.
.684600E+04
0.

1.00000
1.00000
50.00000
1.00000
50.00000
1.00000
14.00000
1.00000
29.00000
50.00000
12.00000
5.00000
1.00000
24.00000
1.00000
5.00000
12.00000

VALUE	STEP
.506500E+04	1
0.	1
.314600E+04	2
0.	6
.314600E+04	7
0.	8
.194000E+05	12
.479000E+04	13
.117900E+05	14
0.	15
.194000E+05	19
.704000E+04	20
.117900E+05	21
0.	22
.314600E+04	23
0.	27
.314600E+04	28
0.	29
.140000E+05	32
.310000E+04	32
.122500E+05	33
.199700E+04	34
.794700E+04	35
0.	36
.314600E+04	37
0.	41
.314600E+04	42
0.	43
.140000E+05	47
.389700E+04	48
.794700E+04	49
0.	50
.914600E+04	51
0.	55
.314600E+04	56
0.	57
.194000E+05	61
.479000E+04	62
.117900E+05	63
0.	64
.194000E+05	68
.704000E+04	69
.117900E+05	70
0.	71
.914600E+04	72
0.	76
.314600E+04	77
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+14	4.00000
3	.821500E+14		.684600E+14	1.00000
4	.606500E+14		0.	24.00000
5	.821500E+14		0.	1.00000
6	.914600E+14		.684600E+14	4.00000
7	.606500E+14		0.	11.00000
8	.117900E+15		.879000E+14	50.00000
9	.135400E+15		.704300E+14	29.00000
10	.172000E+15		.129000E+15	14.00000
11	.157900E+15		.107300E+15	1.00000
12	.117900E+15		.879000E+14	99.00000
13	.157900E+15		.479300E+14	1.00000
14	.172000E+15		.129000E+15	14.00000
15	.135400E+15		.107300E+15	1.00000
16	.117900E+15		.879000E+14	28.00000
17	.157900E+15		.479300E+14	49.00000
18	.172000E+15		.129000E+15	11.00000
19	.135400E+15		.107300E+15	4.00000
20	.117900E+15		.879000E+14	1.00000
21	.157900E+15		.479300E+14	24.00000
22	.172000E+15		.129000E+15	1.00000
23	.135400E+15		.107300E+15	4.00000
24	.117900E+15		.879000E+14	1.00000
25	.157900E+15		.479300E+14	11.00000
26	.172000E+15		.129000E+15	50.00000
27	.135400E+15		.107300E+15	24.00000
28	.117900E+15		.879000E+14	1.00000
29	.157900E+15		.479300E+14	4.00000
30	.172000E+15		.129000E+15	11.00000
31	.135400E+15		.107300E+15	50.00000
32	.117900E+15		.879000E+14	24.00000
33	.157900E+15		.479300E+14	23.00000
34	.172000E+15		.129000E+15	1.00000
35	.135400E+15		.107300E+15	49.00000
36	.117900E+15		.879000E+14	1.00000
37	.157900E+15		.479300E+14	11.00000
38	.172000E+15		.129000E+15	4.00000
39	.135400E+15		.107300E+15	24.00000
40	.117900E+15		.879000E+14	1.00000
41	.157900E+15		.479300E+14	4.00000
42	.172000E+15		.129000E+15	11.00000
43	.135400E+15		.107300E+15	50.00000
44	.117900E+15		.879000E+14	24.00000
45	.157900E+15		.479300E+14	1.00000
46	.172000E+15		.129000E+15	24.00000
47	.135400E+15		.107300E+15	1.00000
48	.117900E+15		.879000E+14	23.00000
49	.157900E+15		.479300E+14	49.00000
50	.172000E+15		.129000E+15	1.00000
51	.135400E+15		.107300E+15	4.00000
52	.117900E+15		.879000E+14	1.00000
53	.157900E+15		.479300E+14	24.00000
54	.172000E+15		.129000E+15	1.00000
55	.135400E+15		.107300E+15	4.00000
56	.117900E+15		.879000E+14	11.00000
57	.157900E+15		.479300E+14	50.00000
58	.172000E+15		.129000E+15	29.00000
59	.135400E+15		.107300E+15	14.00000
60	.117900E+15		.879000E+14	1.00000
61	.157900E+15		.479300E+14	1.00000
62	.172000E+15		.129000E+15	99.00000
63	.135400E+15		.107300E+15	

67	.157900E+05	.479300E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
69	.135400E+05	.107000E+05	1.00000
69	.135400E+05	.704000E+04	28.00000
70	.117900E+05	.879000E+04	49.00000
71	.606500E+04	0.	11.00000
72	.914600E+04	.684600E+04	4.00000
73	.821500E+04	.684600E+04	1.00000
74	.606500E+04	0.	24.00000
76	.821500E+04	0.	1.00000
77	.914600E+04	.684600E+04	4.00000
78	.606500E+04	0.	11.00000

VALUE	STEP
.506500E+04	1
0.	1
.194000E+05	12
0.	15
.194000E+05	19
0.	29
.140000E+05	32
0.	43
.140000E+05	47
0.	57
.194000E+05	61
0.	64
.194000E+05	68
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+04		0.	24.00000
6	.821500E+14		0.	1.00000
7	.914600E+14		.684600E+04	4.00000
8	.606500E+14		0.	11.00000
9	.117900E+15		.879000E+04	50.00000
10	.135400E+15		.764000E+04	29.00000
11	.172000E+15		.129000E+05	14.00000
13	.157900E+15		.107000E+05	1.00000
14	.117900E+15		.879000E+04	99.00000
18	.157900E+15		.479000E+04	1.00000
18	.172000E+15		.129000E+05	14.00000
20	.135400E+15		.107000E+05	1.00000
20	.117900E+15		.879000E+04	28.00000
21	.606500E+14		.684600E+04	49.00000
22	.914600E+14		0.	11.00000
23	.821500E+14		.684600E+04	4.00000
24	.606500E+14		.684600E+04	1.00000
25	.606500E+14		0.	24.00000
27	.821500E+14		0.	1.00000
28	.914600E+14		.684600E+04	4.00000
29	.606500E+14		0.	11.00000
31	.794700E+14		.544700E+04	50.00000
31	.949700E+14		.389700E+04	24.00000
33	.122500E+05		.985000E+04	23.00000
34	.113970E+15		.885000E+04	1.00000
35	.794700E+14		.544700E+04	49.00000
36	.606500E+14		.684600E+04	1.00000
36	.606500E+14		0.	11.00000
37	.914600E+14		.684600E+04	4.00000
38	.821500E+14		.684600E+04	1.00000
39	.606500E+14		0.	24.00000
41	.821500E+14		0.	1.00000
42	.914600E+14		.684600E+04	4.00000
43	.606500E+14		0.	11.00000
44	.794700E+14		.544700E+04	50.00000
46	.113970E+15		.199700E+04	1.00000
46	.122500E+05		.985000E+04	24.00000
48	.949700E+14		.810000E+04	1.00000
48	.949700E+14		.389700E+04	23.00000
49	.794700E+14		.544700E+04	49.00000
50	.606500E+14		.684600E+04	1.00000
51	.606500E+14		0.	11.00000
51	.914600E+14		.684600E+04	4.00000
52	.821500E+14		.684600E+04	1.00000
53	.606500E+14		0.	24.00000
55	.821500E+14		0.	1.00000
56	.914600E+14		.684600E+04	4.00000
57	.606500E+14		0.	11.00000
58	.117900E+15		.879000E+04	50.00000
59	.135400E+15		.764000E+04	29.00000
60	.172000E+15		.129000E+05	14.00000
62	.157900E+15		.107000E+05	1.00000
63	.117900E+15		.879000E+04	99.00000

67	.157900E+05	.479000E+04	1.00000
67	.172000E+05	.129300E+05	14.00000
69	.135400E+05	.107300E+05	1.00000
69	.135400E+05	.704000E+04	28.00000
70	.117900E+05	.879000E+04	49.00000
71	.606500E+04	0.	11.00000
72	.914600E+04	.684600E+04	4.00000
73	.821500E+04	.684600E+04	1.00000
74	.606500E+04	0.	24.00000
76	.821500E+04	0.	1.00000
77	.914600E+04	.684600E+04	4.00000
78	.606500E+04	0.	11.00000
2	.914600E+04	0.	1.00000
7	.117900E+05	.479000E+04	1.00000
14	.117900E+05	.704000E+04	1.00000
21	.914600E+04	0.	1.00000
23	.914600E+04	0.	1.00000
28	.122500E+05	.810300E+04	1.00000
33	.794700E+04	.199700E+04	1.00000
35	.914600E+04	0.	1.00000
37	.914600E+04	0.	1.00000
42	.794700E+04	.389700E+04	1.00000
49	.914600E+04	0.	1.00000
51	.914600E+04	0.	1.00000
56	.117900E+05	.479000E+04	1.00000
63	.117900E+05	.704000E+04	1.00000
70	.914600E+04	0.	1.00000
72	.914600E+04	0.	1.00000
77	.914600E+04	0.	1.00000

MEMBERS OF RESIDUE SPECTRUM 3 = 4

VALUE	STEP
.506500E+04	1
0.	1
.194000E+05	19
0.	78

STEP	MAXIMUM	SIGNA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+14		0.	24.00000
5	.821500E+14		0.	1.00000
6	.914600E+14		.684600E+04	4.00000
7	.606500E+14		0.	11.00000
8	.117900E+15		.879000E+04	50.00000
9	.135400E+15		.764300E+04	29.00000
10	.172300E+15		.129000E+05	14.00000
11	.157900E+15		.107000E+05	1.00000
12	.117900E+15		.879000E+04	99.00000
13	.157900E+15		.479000E+04	1.00000
14	.172300E+15		.129000E+05	14.00000
15	.135400E+15		.107000E+05	1.00000
16	.117900E+15		.879000E+04	28.00000
17	.157900E+15		.479000E+04	49.00000
18	.172300E+15		.129000E+05	11.00000
19	.135400E+15		.107000E+05	4.00000
20	.117900E+15		.879000E+04	24.00000
21	.157900E+15		.479000E+04	1.00000
22	.172300E+15		.129000E+05	1.00000
23	.135400E+15		.107000E+05	4.00000
24	.117900E+15		.879000E+04	11.00000
25	.157900E+15		.479000E+04	50.00000
26	.172300E+15		.129000E+05	24.00000
27	.135400E+15		.107000E+05	23.00000
28	.117900E+15		.879000E+04	1.00000
29	.157900E+15		.479000E+04	49.00000
30	.172300E+15		.129000E+05	11.00000
31	.135400E+15		.107000E+05	4.00000
32	.117900E+15		.879000E+04	24.00000
33	.157900E+15		.479000E+04	1.00000
34	.172300E+15		.129000E+05	1.00000
35	.135400E+15		.107000E+05	4.00000
36	.117900E+15		.879000E+04	11.00000
37	.157900E+15		.479000E+04	4.00000
38	.172300E+15		.129000E+05	1.00000
39	.135400E+15		.107000E+05	24.00000
40	.117900E+15		.879000E+04	1.00000
41	.157900E+15		.479000E+04	4.00000
42	.172300E+15		.129000E+05	11.00000
43	.135400E+15		.107000E+05	50.00000
44	.117900E+15		.879000E+04	24.00000
45	.157900E+15		.479000E+04	1.00000
46	.172300E+15		.129000E+05	1.00000
47	.135400E+15		.107000E+05	4.00000
48	.117900E+15		.879000E+04	23.00000
49	.157900E+15		.479000E+04	49.00000
50	.172300E+15		.129000E+05	1.00000
51	.135400E+15		.107000E+05	11.00000
52	.117900E+15		.879000E+04	4.00000
53	.157900E+15		.479000E+04	1.00000
54	.172300E+15		.129000E+05	24.00000
55	.135400E+15		.107000E+05	1.00000
56	.117900E+15		.879000E+04	4.00000
57	.157900E+15		.479000E+04	11.00000
58	.172300E+15		.129000E+05	50.00000
59	.135400E+15		.107000E+05	29.00000
60	.117900E+15		.879000E+04	14.00000
61	.157900E+15		.479000E+04	1.00000
62	.172300E+15		.129000E+05	1.00000
63	.135400E+15		.107000E+05	99.00000

67	.157900E+15	.479900E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
69	.135400E+15	.107000E+05	1.00000
69	.135400E+15	.704000E+04	28.00000
70	.117900E+15	.879900E+04	49.00000
71	.606500E+14	0.	11.00000
72	.914600E+14	.684600E+04	4.00000
73	.821500E+14	.684600E+04	1.00000
74	.606500E+14	0.	24.00000
76	.821500E+14	0.	1.00000
77	.914600E+14	.684600E+04	1.00000
78	.606500E+14	0.	11.00000
2	.914600E+14	0.	1.09999
7	.914600E+14	0.	1.00000
14	.117900E+15	.479900E+04	1.00000
21	.117900E+15	.704000E+04	1.00000
23	.914600E+14	0.	1.00600
28	.914600E+14	0.	1.00000
33	.122500E+15	.810000E+04	1.00000
35	.794700E+14	.199700E+04	1.00000
37	.914600E+14	0.	1.00000
42	.914600E+14	0.	1.00000
49	.794700E+14	.389700E+04	1.00000
51	.914600E+14	0.	1.00000
56	.914600E+14	0.	1.00000
63	.117900E+15	.479900E+04	1.00000
70	.117900E+15	.704000E+04	1.00000
72	.914600E+14	0.	1.00000
77	.914600E+14	0.	1.00000
12	.194000E+15	0.	1.00000
32	.140000E+15	0.	1.00000
47	.140000E+15	0.	1.00000
61	.194000E+15	0.	1.00000
68	.194000E+15	0.	1.00000

MEMBERS OF RESIDUE SPECTRUM 4 = 4

VALUE	STEP
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.606500E+04	1
0.	1
.194000E+05	19
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+14		0.	24.00000
6	.821500E+14		0.	1.00000
7	.914600E+14		.684600E+04	4.00000
8	.606500E+04		0.	11.00000
9	.117900E+15		.879000E+04	50.00000
10	.135400E+15		.704300E+04	29.00000
11	.172000E+05		.129000E+05	14.00000
13	.157900E+15		.167000E+05	1.00000
14	.117900E+15		.879000E+04	99.00000
16	.157900E+15		.479000E+04	1.00000
18	.172000E+15		.129000E+05	14.00000
20	.135400E+15		.107000E+05	28.00000
21	.117900E+15		.704300E+04	49.00000
22	.606500E+14		.879000E+04	11.00000
23	.914600E+14		.684600E+04	4.00000
24	.821500E+14		.684600E+04	1.00000
25	.606500E+14		0.	24.00000
27	.821500E+14		0.	1.00000
28	.914600E+14		.684600E+04	4.00000
29	.606500E+14		0.	11.00000
30	.794700E+14		.544700E+04	50.00000
31	.949700E+14		.389700E+04	24.00000
33	.122500E+15		.985000E+04	23.00000
34	.113970E+15		.985000E+04	1.00000
35	.794700E+14		.544700E+04	49.00000
36	.606500E+14		.544700E+04	1.00000
37	.914600E+14		0.	11.00000
38	.821500E+14		.684600E+04	4.00000
39	.606500E+14		.684600E+04	1.00000
41	.821500E+14		0.	24.00000
42	.914600E+14		.684600E+04	1.00000
43	.606500E+14		0.	11.00000
44	.794700E+04		.544700E+04	50.00000
46	.113970E+15		.199700E+04	1.00000
48	.122500E+05		.985000E+04	24.00000
49	.949700E+14		.810000E+04	1.00000
48	.949700E+14		.389700E+04	23.00000
49	.794700E+14		.544700E+04	49.00000
50	.606500E+14		.544700E+04	1.00000
51	.914600E+14		0.	11.00000
52	.821500E+14		.684600E+04	4.00000
53	.606500E+14		.684600E+04	1.00000
55	.821500E+14		0.	24.00000
56	.914600E+14		.684600E+04	1.00000
57	.606500E+14		0.	11.00000
58	.117900E+15		.879000E+04	50.00000
59	.135400E+15		.704300E+04	29.00000
60	.172000E+15		.129000E+05	14.00000
62	.157900E+15		.107000E+05	1.00000
63	.117900E+15		.879000E+04	99.00000

67	.157900E+J5	.479000E+J4	1.00000
67	.172000E+J5	.129000E+J5	14.00000
69	.135400E+J5	.107000E+J5	1.00000
69	.135400E+J5	.704000E+J4	28.00000
70	.117900E+J5	.879000E+J4	49.00000
71	.606500E+J4	0.	11.00000
72	.914600E+J4	.684600E+J4	4.00000
73	.821500E+J4	.684600E+J4	1.00000
74	.606500E+J4	0.	24.00000
76	.821500E+J4	0.	1.00000
77	.914600E+J4	.684600E+J4	1.00000
78	.606500E+J4	0.	4.00000
2	.914600E+J4	0.	11.00000
7	.914600E+J4	0.	1.00000
14	.117900E+J5	.479000E+J4	1.00000
21	.117900E+J5	.704000E+J4	1.00000
21	.914600E+J4	0.	1.00000
21	.914600E+J4	0.	1.00000
28	.914600E+J4	0.	1.00000
33	.122500E+J5	.840000E+J4	1.00000
35	.794700E+J4	.199700E+J4	1.00000
37	.914600E+J4	0.	1.00000
42	.914600E+J4	0.	1.00000
49	.794700E+J4	.389700E+J4	1.00000
51	.914600E+J4	0.	1.00000
56	.914600E+J4	0.	1.00000
63	.117900E+J5	.479000E+J4	1.00000
70	.117900E+J5	.704000E+J4	1.00000
72	.914600E+J4	0.	1.00000
77	.914600E+J4	0.	1.00000
12	.194300E+J5	0.	1.00000
32	.140000E+J5	0.	1.00000
47	.140000E+J5	0.	1.00000
61	.194300E+J5	0.	1.00000
68	.194300E+J5	0.	1.00000

CYCLES GENERATED FROM LAST RESIDUE SPECTRUM - NO RANGE PAIR COUNTING = 2

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.634630E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+14		0.	24.00000
5	.914600E+14		0.	1.00000
6	.606500E+14		.684630E+04	4.00000
7	.821500E+14		0.	11.00000
8	.606500E+14		.684630E+04	50.00000
9	.117900E+15		.579300E+04	29.00000
10	.135400E+15		.764330E+04	14.00000
11	.172000E+05		.129000E+05	1.00000
12	.157900E+15		.127030E+05	99.00000
13	.117900E+15		.879300E+04	1.00000
14	.157900E+15		.479300E+04	1.00000
15	.172000E+15		.129000E+05	1.00000
16	.135400E+15		.127030E+05	28.00000
17	.135400E+15		.764330E+04	49.00000
18	.117900E+15		.879300E+04	11.00000
19	.606500E+14		.684630E+04	4.00000
20	.914600E+14		.684630E+04	1.00000
21	.821500E+14		0.	24.00000
22	.606500E+14		.684630E+04	1.00000
23	.914600E+14		.684630E+04	4.00000
24	.821500E+14		0.	11.00000
25	.606500E+14		.684630E+04	50.00000
26	.914600E+14		.684630E+04	29.00000
27	.821500E+14		0.	14.00000
28	.606500E+14		.684630E+04	1.00000
29	.914600E+14		.684630E+04	28.00000
30	.821500E+14		0.	49.00000
31	.606500E+14		.684630E+04	11.00000
32	.914600E+14		.684630E+04	4.00000
33	.821500E+14		.684630E+04	1.00000
34	.606500E+14		.684630E+04	24.00000
35	.914600E+14		.684630E+04	1.00000
36	.821500E+14		.684630E+04	4.00000
37	.606500E+14		.684630E+04	1.00000
38	.914600E+14		.684630E+04	4.00000
39	.821500E+14		.684630E+04	24.00000
40	.606500E+14		.684630E+04	1.00000
41	.914600E+14		.684630E+04	4.00000
42	.821500E+14		.684630E+04	1.00000
43	.606500E+14		.684630E+04	24.00000
44	.914600E+14		.684630E+04	1.00000
45	.821500E+14		.684630E+04	4.00000
46	.606500E+14		.684630E+04	1.00000
47	.914600E+14		.684630E+04	24.00000
48	.821500E+14		.684630E+04	1.00000
49	.606500E+14		.684630E+04	23.00000
50	.914600E+14		.684630E+04	4.00000
51	.821500E+14		.684630E+04	1.00000
52	.606500E+14		.684630E+04	11.00000
53	.914600E+14		.684630E+04	4.00000
54	.821500E+14		.684630E+04	24.00000
55	.606500E+14		.684630E+04	1.00000
56	.914600E+14		.684630E+04	4.00000
57	.821500E+14		.684630E+04	1.00000
58	.606500E+14		.684630E+04	24.00000
59	.914600E+14		.684630E+04	1.00000
60	.821500E+14		.684630E+04	4.00000
61	.606500E+14		.684630E+04	1.00000
62	.914600E+14		.684630E+04	24.00000
63	.821500E+14		.684630E+04	1.00000
64	.606500E+14		.684630E+04	99.00000
65	.914600E+14		.684630E+04	1.00000
66	.821500E+14		.684630E+04	4.00000
67	.606500E+14		.684630E+04	1.00000
68	.914600E+14		.684630E+04	14.00000

69	.135400E+J5	.107300E+J5	1.00000
69	.135400E+J5	.704000E+04	28.00000
70	.117900E+J5	.879300E+J4	49.00000
71	.606500E+J4	0.	11.00000
72	.914600E+J4	.684600E+04	4.00000
73	.821500E+J4	.684600E+04	1.00000
74	.606500E+J4	0.	24.00000
76	.821500E+J4	0.	1.00000
77	.914600E+J4	.684600E+04	4.00000
78	.606500E+J4	0.	11.00000
2	.914600E+J4	0.	1.00000
7	.914600E+J4	0.	1.00000
14	.117900E+J5	.479000E+J4	1.00000
21	.117900E+J5	.704000E+04	1.00000
23	.914600E+J4	0.	1.00000
28	.914600E+J4	0.	1.00000
33	.122500E+J5	.810000E+04	1.00000
35	.794700E+J4	.199700E+04	1.00000
37	.914600E+J4	0.	1.00000
42	.914600E+J4	0.	1.00000
49	.794700E+J4	.389700E+04	1.00000
51	.914600E+J4	0.	1.00000
56	.914600E+J4	0.	1.00000
63	.117900E+J5	.479000E+J4	1.00000
70	.914600E+J4	.704000E+04	1.00000
72	.914600E+J4	0.	1.00000
77	.194000E+J5	0.	1.00000
12	.194000E+J5	0.	1.00000
32	.140000E+J5	0.	1.00000
47	.140000E+J5	0.	1.00000
61	.194000E+J5	0.	1.00000
68	.194000E+J5	0.	1.00000
19	.194000E+J5	0.	1.00000
1	.606500E+J4	0.	1.00000

RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+J4	0.	0.	12.00000
2	.914600E+J4	.684600E+04	.684600E+04	4.00000
3	.914600E+J4	0.	0.	1.00000
4	.821500E+J4	.684600E+J4	.684600E+J4	1.00000
5	.606500E+J4	0.	0.	24.00000
6	.821500E+04	0.	0.	1.00000
7	.914600E+J4	.684600E+04	.684600E+04	4.00000
8	.914600E+J4	0.	0.	1.00000
9	.606500E+04	0.	0.	11.00000
10	.117900E+J5	.879300E+J4	.879300E+J4	50.00000
11	.135400E+J5	.704300E+J4	.704300E+J4	29.00000
12	.172300E+J5	.129000E+05	.129000E+05	14.00000
13	.194000E+J5	0.	0.	1.00000
14	.157900E+J5	.107000E+05	.107000E+05	1.00000
15	.117900E+J5	.879300E+04	.879300E+04	99.00000
16	.117900E+05	.479000E+04	.479000E+04	1.00000
17	.157900E+J5	.479000E+04	.479000E+04	1.00000
18	.172000E+J5	.129000E+J5	.129000E+J5	14.00000
19	.194000E+05	0.	0.	1.00000
20	.135400E+J5	.107000E+05	.107000E+05	1.00000
21	.135400E+J5	.704300E+J4	.704300E+J4	28.00000
22	.117900E+J5	.879300E+J4	.879300E+J4	49.00000
23	.117900E+J5	.704300E+J4	.704300E+J4	1.00000
24	.606500E+J4	0.	0.	11.00000
25	.914600E+J4	.684600E+04	.684600E+04	4.00000
26	.914600E+04	0.	0.	1.00000
27	.821500E+J4	.684600E+04	.684600E+04	1.00000
28	.606500E+J4	0.	0.	24.00000
29	.821500E+04	0.	0.	1.00000
30	.914600E+J4	.684600E+J4	.684600E+J4	4.00000
31	.914600E+J4	0.	0.	1.00000
32	.606500E+J4	0.	0.	11.00000
33	.794700E+J4	.544700E+J4	.544700E+J4	50.00000
34	.949700E+J4	.389700E+J4	.389700E+J4	24.00000
35	.140000E+05	0.	0.	1.00000
36	.122500E+J5	.985000E+J4	.985000E+J4	23.00000
37	.122500E+J5	.810300E+J4	.810300E+J4	1.00000
38	.113970E+J5	.985000E+04	.985000E+04	1.00000
39	.794700E+J4	.544700E+J4	.544700E+J4	49.00000
40	.794700E+J4	.199700E+J4	.199700E+J4	1.00000
41	.606500E+J4	.544700E+04	.544700E+04	1.00000
42	.606500E+J4	0.	0.	11.00000
43	.914600E+J4	.684600E+J4	.684600E+J4	4.00000
44	.914600E+J4	0.	0.	1.00000
45	.821500E+04	.684600E+04	.684600E+04	1.00000
46	.606500E+J4	0.	0.	24.00000
47	.821500E+J4	0.	0.	1.00000
48	.914600E+04	.684600E+04	.684600E+04	4.00000
49	.914600E+J4	0.	0.	1.00000
50	.606500E+J4	0.	0.	11.00000
51	.794700E+J4	.544700E+04	.544700E+04	50.00000
52	.113970E+J5	.199700E+04	.199700E+04	1.00000
53	.122500E+J5	.985000E+J4	.985000E+J4	24.00000
54	.140000E+J5	0.	0.	1.00000
55	.949700E+04	.810300E+J4	.810300E+J4	1.00000
56	.949700E+J4	.389700E+04	.389700E+04	23.00000

57	.794700E+J4	.544700E+J4	49.00000
58	.794700E+04	.389700E+04	1.00000
59	.606500E+J4	.544700E+J4	1.00000
60	.606500E+J4	0.	11.00000
61	.914600E+J4	.684600E+04	4.00000
62	.914600E+J4	0.	1.00000
63	.821500E+J4	.684600E+J4	1.00000
64	.606500E+J4	0.	24.00000
65	.821500E+J4	0.	1.00000
66	.914600E+J4	.684600E+J4	4.00000
67	.914600E+J4	0.	1.00000
68	.606500E+J4	0.	11.00000
69	.117900E+J5	.879000E+J4	50.00000
70	.135400E+J5	.704000E+J4	29.00000
71	.172000E+J5	.129000E+05	14.00000
72	.194000E+J5	0.	1.00000
73	.157900E+J5	.107000E+05	1.00000
74	.117900E+J5	.879000E+04	99.00000
75	.117900E+J5	.479000E+J4	1.00000
76	.157900E+J5	.479000E+J4	1.00000
77	.172000E+J5	.129000E+J5	14.00000
78	.194000E+J5	0.	1.00000
79	.135400E+J5	.107000E+J5	1.00000
80	.135400E+05	.704000E+04	28.00000
81	.117900E+J5	.879000E+J4	49.00000
82	.117900E+J5	.704000E+J4	1.00000
83	.606500E+J4	0.	11.00000
84	.914600E+J4	.684600E+J4	4.00000
85	.914600E+J4	0.	1.00000
86	.821500E+J4	.684600E+J4	1.00000
87	.606500E+J4	0.	24.00000
88	.821500E+J4	0.	1.00000
89	.914600E+J4	.684600E+04	4.00000
90	.914600E+J4	0.	1.00000
91	.606500E+J4	0.	11.00000

2. 5.0g Flight by Flight Spectrum

5.J5 FLIGHT BY FLIGHT SPECTRUM

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 74

STEP	SIGMA	MAXIMUM	MINIMUM	COUNTER K
1		.423000E+12	.277000E+12	1.00000
2		.493000E+12	.231000E+12	1.00000
3		.396000E+12	.231000E+12	1.00000
4		.396000E+12	.231000E+12	1.00000
5		.493000E+12	.231000E+12	1.00000
6		.456000E+12	.230000E+12	1.00000
7		.479000E+12		1.00000
8		.423000E+12		1.00000
9		.283000E+12	.230000E+12	1.00000
10		.308000E+12	.152000E+12	1.00000
11		.583000E+12	.233000E+12	1.00000
12		.308000E+12	.152000E+12	1.00000
13		.308000E+12	.152000E+12	1.00000
14		.668000E+12	.230000E+12	1.00000
15		.456000E+12	.230000E+12	1.00000
16		.308000E+12	.152000E+12	1.00000
17		.308000E+12	.152000E+12	1.00000
18		.490000E+12	.227000E+12	1.00000
19		.308000E+12	.152000E+12	1.00000
20		.308000E+12	.152000E+12	1.00000
21		.345000E+12	.112000E+12	1.00000
22		.308000E+12	.152000E+12	1.00000
23		.308000E+12	.152000E+12	1.00000
24		.299000E+12	.113000E+12	1.00000
25		.299000E+12	.220000E+12	1.00000
26		.408000E+12	.116000E+12	1.00000
27		.504000E+12	.220000E+12	1.00000
28		.299000E+12	.116000E+12	1.00000
29		.299000E+12	.220000E+12	1.00000
30		.299000E+12	.116000E+12	1.00000
31		.408000E+12	.220000E+12	1.00000
32		.504000E+12	.116000E+12	1.00000
33		.408000E+12	.113000E+12	1.00000
34		.593000E+12	.220000E+12	1.00000
35		.517000E+12	.203000E+12	1.00000
36		.402000E+12	.203000E+12	1.00000
37		.402000E+12	.203000E+12	1.00000
38		.736000E+12	.203000E+12	1.00000
39		.778000E+12	.203000E+12	1.00000
40		.517000E+12	.203000E+12	1.00000
41		.517000E+12	.203000E+12	1.00000
42		.648000E+12	.203000E+12	1.00000
43		.648000E+12	.203000E+12	1.00000
44		.366000E+12	.198000E+12	1.00000
45		.366000E+12	.198000E+12	1.00000
46		.464000E+12	.143000E+12	1.00000
47		.395000E+12	.143000E+12	1.00000
48		.395000E+12	.140000E+12	1.00000
49		.307000E+12	.104000E+12	1.00000
50		.395000E+12	.104000E+12	1.00000
51		.498000E+12	.140000E+12	1.00000
52		.307000E+12	.104000E+12	1.00000
53		.307000E+12	.140000E+12	1.00000

54	.428000E+J2	.2000J1E+J2	1.00000
55	.502000E+J2	.200J1E+J2	1.00000
56	.366000E+J2	.2000J1E+J2	1.00000
57	.564000E+J2	.2000J1E+J2	1.00000
58	.470000E+J2	.2000J1E+J2	1.00000
59	.526000E+J2	.2000J1E+J2	1.00000
60	.470000E+J2	.2000J1E+J2	1.00000
61	.254000E+J2	.4700J1E+J1	1.00000
62	.254000E+J2	--.1600J1E+J1	1.00000
63	.184000E+J2	--.1600J1E+J1	3.00000
64	.338000E+J2	.114000E+J2	1.00000
65	.356000E+J2	.151000E+J2	1.00000
66	.306000E+J2	.1510J1E+J2	1.00000
67	.396000E+J2	.230000E+J2	1.00000
68	.456000E+J2	.228J1E+J2	1.00000
69	.306000E+J2	.1510J1E+J2	1.00000
70	.593000E+J2	.228000E+J2	1.00000
71	.356000E+J2	.1510J1E+J2	1.00000
72	.583000E+J2	.228J1E+J2	1.00000
73	.366000E+J2	.222000E+J2	1.00000
74	.503000E+J2	.294J1E+J2	2.00000

STEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OCCUR CONSECUTIVELY IN THE LOAD SPECTRUM

4 13 17 20 23 37 41 43 45 66

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.423000E+02		.277000E+02	1.00000
2	.493000E+02		.231000E+02	1.00000
3	.396000E+02		.231000E+02	2.00000
5	.493000E+02		.231000E+02	1.00000
6	.456000E+02		.231000E+02	1.00000
7	.479000E+02		0.	1.00000
8	.342000E+02		0.	4.00000
9	.283000E+02		.230000E+02	1.00000
10	.308000E+02		.152000E+02	1.00000
11	.583000E+02		.230000E+02	1.00000
12	.328000E+02		.152000E+02	2.00000
14	.688000E+02		.230000E+02	1.00000
15	.456000E+02		.230000E+02	1.00000
16	.396000E+02		.152000E+02	4.00000
18	.490000E+02		.227000E+02	1.00000
19	.308000E+02		.152000E+02	2.00000
21	.345000E+02		.112000E+02	1.00000
22	.308000E+02		.152000E+02	2.00000
24	.299000E+02		.111000E+02	5.00000
25	.299000E+02		.220000E+02	4.00000
26	.408000E+02		.116000E+02	3.00000
27	.504000E+02		.220000E+02	1.00000
28	.299000E+02		.116000E+02	7.00000
29	.299000E+02		.220000E+02	13.00000
31	.299000E+02		.116000E+02	8.00000
32	.408000E+02		.220000E+02	5.00000
33	.504000E+02		.116000E+02	1.00000
34	.299000E+02		.220000E+02	1.00000
35	.517000E+02		.233000E+02	1.00000
36	.402000E+02		.203000E+02	2.00000
38	.736000E+02		.233000E+02	1.00000
39	.778000E+02		.203000E+02	1.00000
40	.517000E+02		.203000E+02	2.00000
42	.648000E+02		.203000E+02	2.00000
44	.366000E+02		.199000E+02	1.00000
46	.464000E+02		.140000E+02	1.00000
47	.395000E+02		.140000E+02	5.00000
48	.395000E+02		.140000E+02	1.00000
49	.307000E+02		.104000E+02	1.00000
50	.395000E+02		.104000E+02	1.00000
51	.498000E+02		.140000E+02	1.00000
52	.307000E+02		.140000E+02	6.00000
53	.307000E+02		.140000E+02	17.00000
54	.428000E+02		.200000E+02	1.00000
55	.502000E+02		.200000E+02	1.00000
56	.366000E+02		.200000E+02	1.00000
57	.564000E+02		.200000E+02	1.00000
58	.470000E+02		.200000E+02	1.00000
59	.526000E+02		.200000E+02	1.00000
60	.470000E+02		.200000E+02	1.00000
61	.254000E+02		.470000E+02	1.00000
62	.254000E+02		.160000E+02	1.00000
63	.184000E+02		.160000E+02	3.00000
64	.338000E+02		.114000E+02	1.00000

65	.306000E+12	.151000E+02	2.00000
67	.396000E+12	.230000E+02	1.00000
68	.456000E+12	.280000E+02	1.00000
69	.306000E+12	.151000E+02	1.00000
70	.583000E+12	.280000E+02	1.00000
71	.306000E+12	.151000E+02	1.00000
72	.583000E+12	.280000E+02	1.00000
73	.366000E+12	.220000E+02	1.00000
74	.503000E+12	.290000E+02	2.00000

RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.42300E+12		.27700E+02	1.00000
2	.49300E+12		3.	1.00000
3	.39600E+12		.23100E+02	2.00000
4	.49300E+12		.23100E+02	1.00000
5	.45600E+12		.23100E+02	1.00000
6	.47900E+12		.23000E+02	1.00000
7	.34200E+12		3.	4.00000
8	.28300E+12		.23000E+02	1.00000
9	.30800E+12		.15200E+02	1.00000
10	.59300E+12		.15200E+02	1.00000
11	.30800E+12		.23000E+02	1.00000
12	.30800E+12		.15200E+02	1.00000
13	.66800E+12		.22000E+02	1.00000
14	.45600E+12		.23000E+02	1.00000
15	.30800E+12		.23000E+02	1.00000
16	.30800E+12		.15200E+02	3.00000
17	.49000E+12		.15200E+02	1.00000
18	.30800E+12		.22700E+02	1.00000
19	.30800E+12		.15200E+02	1.00000
20	.34500E+12		.15200E+02	1.00000
21	.30800E+12		.15200E+02	1.00000
22	.30800E+12		.11200E+02	1.00000
23	.29900E+12		.15200E+02	1.00000
24	.29900E+12		.11000E+02	5.00000
25	.29900E+12		.22000E+02	3.00000
26	.40800E+12		.11600E+02	3.00000
27	.50400E+12		.22000E+02	1.00000
28	.29900E+12		.11600E+02	7.00000
29	.29900E+12		.22000E+02	13.00000
30	.29900E+12		.11600E+02	9.00000
31	.40800E+12		.22000E+02	5.00000
32	.50400E+12		.11600E+02	1.00000
33	.48200E+12		.11600E+02	1.00000
34	.59300E+12		.22000E+02	1.00000
35	.51700E+12		.22000E+02	1.00000
36	.40200E+12		.22000E+02	2.00000
37	.73600E+12		.22000E+02	1.00000
38	.77800E+12		.16000E+02	1.00000
39	.51700E+12		.22000E+02	2.00000
40	.64600E+12		.22000E+02	2.00000
41	.36600E+12		.22000E+02	1.00000
42	.36600E+12		.19000E+02	1.00000
43	.46400E+12		.19000E+02	1.00000
44	.39500E+12		.16000E+02	1.00000
45	.29500E+12		.14000E+02	5.00000
46	.30700E+12		.16000E+02	11.00000
47	.39500E+12		.14000E+02	1.00000
48	.49800E+12		.14000E+02	1.00000
49	.30700E+12		.14000E+02	17.00000
50	.30700E+12		.14000E+02	6.00000
51	.42800E+12		.20000E+02	1.00000
52	.50200E+12		.20000E+02	1.00000
53	.36600E+12		.20000E+02	1.00000
54	.56400E+12		.14000E+02	1.00000
55	.47000E+12		.20000E+02	1.00000

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.526000E+12
.470000E+12
.254000E+12
.254000E+12
.184000E+12
.338000E+12
.336000E+12
.396000E+12
.456000E+12
.366000E+12
.583000E+12
.583000E+12
.366000E+12
.503000E+12

.200000E+02
.200000E+02
.200000E+02
.470000E+11
-
.160000E+01
.114000E+12
.151000E+12
.230000E+02
.151000E+12
.228000E+12
.151000E+02
.222000E+02
.228000E+12
.294000E+12

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APPENDIX II
PROGRAM LISTING

PROGRAM RPCH TRACE

PROGRAM RPCH(INPUT,TAPE5=INPUT,OUTPUT,TAPE6=OUTPUT,PUNCH)

THIS PROGRAM EMPLOYS THE RANGE PAIR CYCLE COUNTING METHOD TO GENERATE AN ANALYSIS SPECTRUM FROM A GIVEN LOAD SPECTRUM

INPUT
CARD 1.

CARD 2.

TITLE = DESCRIPTION OF THE INPUT LOAD SPECTRUM, S
FORMAT 8A10
NPKS = NUMBER OF PEAKS OR VALLEYS IN THE
LOAD SPECTRUM
NPUNCH = PUNCH FLAG SUCH THAT NPUNCH
NOT EQUAL TO ZERO IMPLIES PUNCH
IN THE RANGE PAIR COUNTED SPECTRUM
IN THE INPUT FORMAT

FORMAT 2I5

CARDS 3,...,NPKS+2.
SIGMAX(I) = ITH PEAK OF THE LOAD SPECTRUM
SIGMIN(I) = ITH VALLEY OF THE LOAD SPECTRUM
RNCYC(I) = COUNTER K OF THE ITH PEAK AND VALLEY
FORMAT 5X,3E10.0

PROGRAM ARRAYS
(INFORMATION NEEDED TO CHANGE DIMENSIONS)

ARRAY NAME	DEFINITION	DIMENSION
SIGMAX	PEAKS OF THE INPUT LOAD SPECTRUM	NPKS + KK
KK	THE NUMBER OF ADDITIONAL CYCLES (EXCLUDING INPUT CYCLES)	
SIGMIN	WHICH THE PROGRAM WILL GENERATE	NPKS + KK
RNCYC	VALLEYS OF THE INPUT LOAD SPECTRUM	NPKS + KK
NSTEP	K COUNTERS OF THE PEAKS AND VALLEYS	NPKS + KK
RES	STEP NUMBERS OF THE INPUT SPECTRUM	2*NPKS
INDEX	RESIDUE SPECTRUM	2*NPKS
CYCLE	STEP NUMBERS OF ELEMENTS IN RES	NPKS + KK
RNECYC	RANGE PAIR COUNTED CYCLES	NPKS + KK
NNSTEP	K COUNTERS OF THE CYCLES OF THE	NPKS + KK
ISAVE	UNSORTED ANALYSIS SPECTRUM	NPKS + KK
	UNSORTED ANALYSIS SPECTRUM	
	VALUES OF NSTEP(J) SUCH THAT RNCYC(J)	99
	IS < 1.0 AND VALUES OF NSTEP(J) SUCH	
	THAT SIGMAX(J-1) = SIGMAX(J) AND	
	SIGMIN(J-1) = SIGMIN(J)	

COMMON/MOEC/SIGMAX(900),SIGMIN(900),NSTEP(900),LR,KMAX,KMIN,K31
COMMON/MOEC/RES(1400),INDEX(1400),IND1,IND2,IND3,IND4,KIND
COMMON/MOYC/CYCLE(900,2),RNECYC(900),NNSTEP(900)
COMMON/PCGOE/L,LIND

DIMENSION RNCYC(900),ISAVE(99),TITLE(8)

NPUNCH = 0
9999
READ(5,18) (TITLE(I), I = 1,8)
IF (EOF(5))9000,9100

18 FORMAT(8A10)

9000 STOP

9100 READ(5,95) NPKS,NPUNCH

95 FORMAT(1X15)

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60      READ(5,101) (SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKS)
        DO 800 I = 1,NPKS
          WRITE(6,19) (TITLE(I), I = 1,9)
          WRITE(6,20) NPKS
          WRITE(6,21) (NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD) SPE
          IGRUM = 15//
          WRITE(6,22)
          WRITE(6,23) (5HSIGMA/31X,4HSTEP,13X,7HMAXIMUM,16X,7HMINIMUM,13X,
            1 9HCCOUNTER K/)
          WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKS)
          WRITE(6,26) (29X,15,10X,E13.6,13X,E13.6,13X,F10.5)
70      C
        C SORT THROUGH THE LOAD SPECTRUM - PULL OUT THOSE PEAKS AND VALLEYS WHOSE
        C COUNTER K IS LESS THAN 1.0
        C
        J = 1
        L = 0
        NPES = 1
        NCYNO = 100
        JMAX = 0
        DO 100 I = 1,NPKS
          IF (RNCYC(I).GE. 1.0) GO TO 100
          X1 = SIGMAX(I)
          X2 = SIGHIN(I)
          CALL CYCGEN(X1,X2 ,RNCYC(I),NSTEP(I))
          ISAVE(J) = I
          J = J + 1
          IF (J.EQ. JMAX) GO TO 100
          JMAX = J - 1
          NPESN = NPKS - JMAX
          IF (JMAX.EQ. 0) GO TO 200
          WRITE(6,23) (ISAVE(K), K = 1,JMAX)
          WRITE(6,24) (9HSTEP NUMBERS OF THOSE PEAKS AND VALLEYS IN THE LOAD
            1 SPECTRUM WHOSE COUNTER K IS LESS THAN 1.0//((17I))
          DO 110 J = 1,JMAX
            I = ISAVE(J) - (J-1)
            NPKN = NPKS - J
            IF (I.EQ. NPKN) GO TO 110
            DO 115 II = I,NPKN
              SIGMAX(II) = SIGMAX(II+1)
              SIGHIN(II) = SIGHIN(II+1)
              NSTEP(II) = NSTEP(II+1)
              RNCYC(II) = RNCYC(II+1)
            115 CONTINUE
            110 CONTINUE
            WRITE(6,24) NPKSN
            WRITE(6,25)
            WRITE(6,26) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKSN)
            200 CONTINUE
        C
        C SORT THROUGH THE LOAD SPECTRUM DATA - COMBINE STEPS WITH IDENTICAL PEAKS
        C AND VALLEYS WHICH OCCUR CONSECUTIVELY
110      C

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C
115 J = 1
    DC 300 I = 2,NPKSN
    IF (SIGMAX(I) .NE. SIGMAX(I-1)) GO TO 300
    IF (SIGMIN(I) .NE. SIGMIN(I-1)) GO TO 300
    ISAVE(J) = I
    RNCYC(I-1) = RNCYC(I-1) + RNCYC(I)
    J = J + 1
120 300 CONTINUE
    IF (J .EQ. 1) GO TO 6000
    JMAS = J - 1
    WRITE(6,26) (ISAVE(K), K = 1,JMAS)
26 FORMAT(1H0,90HSTEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OC
125 1CUR, CONSECUTIVELY IN THE LOAD SPECTRUM// (1717)
    DO 311 J = 1,JMAS
        I = ISAVE(J) - (J-1)
        NPKN = NPKSN - J
        IF (I .EQ. NPKN) GO TO 311
        OC 316 II = I,NPKN
        SIGMAX(II) = SIGMAX(II+1)
        SIGMIN(II) = SIGMIN(II+1)
        NSTEP(II) = NSTEP(II+1)
        RNCYC(II) = RNCYC(II+1)
130 316 CONTINUE
135 311 CONTINUE
        NPKSN = NPKSN - JMAS
        WRITE(6,24) NPKSN
24 FORMAT(1H1,54HLOAD SPECTRUM DATA ADJUSTED FOR RANGE PAIR COUNTING
140 1= ,15//)
        WRITE(6,22)
        WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I), I = 1,NPKSN)
C
C
C
145 6000 I = 1
        K8 = 1
        L = JMAX
        KMIN = 0
        KHAX = 0
        LR = C
        K31 = 0
150 1 IF (RNCYC(I) .GT. 1.0) GO TO 400
        IF (K8 .NE. 0) GO TO 5
        X1 = SIGMAX(I)
        X2 = SIGMIN(I)
        IND1 = NSTEP(I)
        IND2 = IND1
        I = I + 1
        K8 = 1
        GO TO 1
155 5 X3 = SIGMAX(I)
        X4 = SIGMIN(I)
        IND3 = NSTEP(I)
        IND4 = IND3
        KMIN = 1
160
165

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170      KMAX = 0
        K31 = 0
        IF (RNCYC(I) .EQ. 1.0) GO TO 5
        KEY = 1
        KIND = 1
        GO TO 415
        6 KEY = 0
        CYCNO = RNCYC(I)
        CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
175      1000 GO TO (10,12,30),KCYGEN
        13 KB = 1
        IF (KMIN .NE. 1) GO TO 36
        I = I + 1
        IF (I .LE. NPKSN) GO TO 5
        RES(LR+1) = X1
        RES(LR+2) = X2
        INDEX(LR+1) = IND1
        INDEX(LR+2) = IND2
        LRMAX = LR + 2
        GO TO 200J
195      30 IF (KMIN .NE. 1) GO TO 35
        12 I = I + 1
        IF (I .LE. NPKSN) GO TO 31
        RES(LR+1) = X1
        RES(LR+2) = X2
        RES(LR+3) = X3
        INDEX(LR+1) = IND1
        INDEX(LR+2) = IND2
        INDEX(LR+3) = IND3
        LRMAX = LR + 3
        GO TO 200J
        31 X4 = SIGMAX(I)
        IND4 = NSTEP(I)
        KMAX = 1
        KMIN = 0
        K31 = 1
200      32 IF (RNCYC(I) .GT. 1.0) GO TO 40
        40 KEY = 1
        KIND = 0
        GO TO 415
205      35 X4 = SIGMIN(I)
        IND4 = NSTEP(I)
        KMIN = 1
        KMAX = 0
        K31 = 0
        GO TO 32
210      36 X3 = SIGMIN(I)
        IND3 = NSTEP(I)
        KMIN = 1
        KMAX = 0
        GO TO 12
215      400 KEY = 1
        IF (KB .NE. 0) GO TO 410
        X1 = SIGMAX(I)
220

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PROGRAM RPCM TRACE

X2 = SIGMIN(I)
X3 = SIGMAX(I)
X4 = SIGMIN(I)
IND1 = NSTEP(I)
IND2 = IND1
IND3 = IND1
IND4 = IND1
KMIN = 1
KMAX = 0
K31 = 0

IF (RNCYC(I) .LE. 2.0) GO TO 401
RNCYC(I) = RNCYC(I) - 1.0
GO TO 402

401 RNCYC(I) = RNCYC(I) - 2.3
402 KIND = 0
GO TO 415

410 X3 = SIGMAX(I)
X4 = SIGMIN(I)
IND3 = NSTEP(I)
IND4 = IND3
KMIN = 1
KMAX = 0
K31 = 0
KIND = 1
RNCYC(I) = RNCYC(I) - 1.0
K2 = 0

415 CYCNO = RNCYC(I)
CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
GO TO 1000
LMAX = L

WRITE(6,2001) NRES,LMAX
2001 FORMAT(1H1,27HMEMBERS OF RESIDUE SPECTRUM,I5,3H = , I5//,55X,
15HVALUE,15X,4HSTEP//)
WRITE(6,2002) (RES(J),INDEX(J), J = 1,LMAX)

2102 FOPMAT(50X,E15.6,10X,I5)
WRITE(6,2003) NRES,LMAX
2003 FORMAT(1H1,40HCYCLES GENERATED BEFORE RESIDUE SPECTRUM,I5,3H = ,
15//)
WRITE(6,22)
WRITE(6,25) (NNSTEP(I),CYCLE(I,1),CYCLE(I,2),RNECYC(I),
1 I = 1,LMAX)

IF (LRMAX .LT. 4) GO TO 5000
IF (NCYNO .EQ. 0) GO TO 5300

C RANGE PAIR COUNT OF RESIDUE SPECTRUMS
C

NRES = NRES + 1
CALL DECRES(LRMAX,NCYNO)
GO TO 2000

5300 IF (LRMAX .LE. 1) GO TO 3000

C COUNT THE LAST RESIDUE SPECTRUM - RANGE PAIR COUNTING WILL YIELD NO
C ADDITIONAL CYCLES
C

KK = 0

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280 RESMAX = RES(1)
    RESMIN = RES(1)
    IMAX = 1
    IMIN = 1
    DO 500 I = 2,LRMAX
    IF (RES(I) .LT. RESMAX) GO TO 490
    RESMAX = RES(I)
    IMAX = I
    GO TO 500
285 490 IF (RES(I) .GT. RESMIN) GO TO 500
    RESMIN = RES(I)
    IMIN = I
    500 CONTINUE
290 CALL CYCRES(RESMAX,RESMIN,1,J,INDEX(IPAX))
    KK = KK + 1
    J = IMAX - 2
    IF (J .LE. 3) GO TO 550
    CALL CYCRES(RES(J),RES(J+1),1,0,INDEX(J))
    KK = KK + 1
    IMAX = J
    GO TO 510
295 510 J = IMIN + 2
    IF (J .GT. LRMAX) GO TO 575
    CALL CYCRES(RES(J-1),RES(J),1,0,INDEX(J-1))
    KK = KK + 1
    IMIN = J
    GO TO 550
300 575 KMAX = KK
    LMAX = L
    WRITE(6,2005) KMAX
2005 FORMAT(1H1,71HCYCLES GENERATED FROM LAST RESIDUE SPECTRUM - NO RAN
    1GE PAIR COUNTING = ,15)
    WRITE(6,22)
    WRITE(6,25) (NNSTEP(I),CYCLE(I,1),CYCLE(I,2),RNECYC(I),
    1 I = 1,LMAX)
310 C
C
C
315 3000 KP = 0
    DO 605 JJ = 1,NPKS
    KC = 0
    DO 600 I = 1,LMAX
    IF (NNSTEP(I) .NE. JJ) GO TO 500
    KP = KP + 1
    KC = KC + 1
    NSTEP(KP) = KP
    SIGNAX(KP) = CYCLE(I,1)
    SIGNIN(KP) = CYCLE(I,2)
    RNECYC(KP) = RNECYC(I)
    IF (KC .LT. 2) GO TO 600
    IF (SIGNAX(KP) .NE. SIGNAX(KP-1)) GO TO 630
    IF (SIGNIN(KP) .NE. SIGNIN(KP-1)) GO TO 630
    595 KP = KP - 1
    600 RNECYC(KP) = RNECYC(KP) + 1.0
    600 CONTINUE
320
325
330

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335 605 CONTINUE
      KPMAX = KP
      WRITE(6,2010)
2010 FORMAT(1H1,48X,33H RANGE PAIR CYCLE COUNTED SPECTRUM//)
      WRITE(6,22)
      IF (NPUNCH .EQ. 0) GO TO 9999
      PUNCH 102, (SIGHAX(I),SIGHIN(I),RNCYC(I), I = 1,KPMAX)
102  GO TO 9999
      END
340

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SUBROUTINE DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
COMMON/HDEC/SIGHAX(900),SIGHTN(900),NSTEP(900),LR,KHAX,KHIN,K31
COMMON/HDEC/RES(1400),INDEX(1400),IND1,IND2,IND3,IND4,KIND
COMMON/MCYG/CYCLE(900,2),RNECYC(900),NNSTEP(900)
COMMON/MCGDE/L,LIND

THIS SUBROUTINE DECIDES WHETHER OR NOT THE VALUES X1,X2,X3, AND X4
FROM THE ADJUSTED LOAD SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS

```

5      C
6      C
7      C
8      C
9      C
10     KFIRST = 0
11     IF (K31.NE. 0) GO TO 11
12     IF (X3.LE. X2) GO TO 203
13     IF (X2.GT. X1) GO TO 213
14     IF (X2.LT. X4.OR. X3.GT. X1) GO TO 500
15     IF (X2.GT. X3) GO TO 151
16     CALL CYCGEN(X3,X2,1.0,NSTEP(I))
17     GO TO 152
18     151 CALL CYCGEN(X2,X3, 1.0,NSTEP(I))
19     152 X1 = X1
20     X2 = X4
21     IF (IND3.NE. IND2) LIND = 1
22     IND2 = IND4
23     KCYGEN = 1
24     IF (KEY.NE. 0) GO TO 113
25     RETURN
26     213 IF (X2.GT. X4.OR. X3.LT. X1) GO TO 500
27     GO TO 150
28     203 X1 = X1
29     X2 = X4
30     IND2 = IND4
31     KCYGEN = 2
32     IF (KEY.EC. 0) RETURN
33     CYCNO = CYCNO - 1.0
34     GO TO 113
35     C
36     C
37     C
38     C
39     C
40     503 LR = LR + 1
41     RES(LR) = X1
42     INDEX(LR) = IND1
43     X1 = X2
44     X2 = X3
45     X3 = X4
46     IND1 = IND2
47     IND2 = IND3
48     IND3 = IND4
49     KCYGEN = 3
50     IF (KEY.NE. 0) GO TO 110
51     RETURN
52     110 GO TO (115,120,150),KCYGEN
53     1150 IF (CYCNO.GT. 1.0) GO TO 1151
54     IF (CYCNO.EQ. 0.0) RETURN
55     1153 CYCNO = CYCNO - 1.0
56     GO TO 1152
57     1151 IF (LIND.EQ. 1) GO TO 1153

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SUBROUTINE DECIDE TRACE

IF (IND3 .NE. IND4) GO TO 1153
RNECYC(L) = RNECYC(L) + CYCNO - 2.0
CYCNO = 1.0

1152 IF (KHAX .NE. 1) GO TO 111

X3 = SIGMIN(I)

IND3 = NSTEP(I)

IF (CYCNO .NE. 0.0) GO TO 112

KHIN = 1

KHAX = 0

KCYGEN = 3

RETURN

1200 IF (CYCNO .EQ. 0.0) RETURN

CYCNO = CYCNO - 1.0

X3 = SIGMAX(I)

X4 = SIGMIN(I)

KFIRST = 1

GO TO 113

111 X3 = SIGMAX(I)

X4 = SIGMIN(I)

IF (KFIRST .NE. 0) GO TO 113

CYCNO = CYCNO - 1.0

KFIRST = 1

113 IND3 = NSTEP(I)

IND4 = IND3

KHIN = 1

KHAX = 0

GO TO 10

1503 IF (KHAX .NE. 0) GO TO 1510

IF (CYCNO .EQ. 0.0) RETURN

CYCNO = CYCNO - 1.0

112 X4 = SIGMAX(I)

IND4 = NSTEP(I)

KHAX = 1

KHIN = 0

GO TO 11

1510 X4 = SIGMIN(I)

IND4 = NSTEP(I)

KHAX = 0

KHIN = 1

GO TO 10

END

SUBROUTINE CYCGEN(Y1,Y2, CYCPF,NSTEPP)
COMMON/MCYG/CYCLE(300,2),RNECYC(900),NNSTEP(900)
COMMON/MCGDE/L,LIND

THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DATA
SUPPLIED BY SUBROUTINE DECIDE

```

5      C
6      C
7      C
8      C
9      LIND = 0
10     L = L + 1
11     CYCLE(L,1) = Y1
12     CYCLE(L,2) = Y2
13     RNECYC(L) = CYCPF
14     NNSTEP(L) = NSTEPP
15     IF (L.EQ.1) GO TO 100
16     IF (CYCLE(L-1,1) .NE. CYCLE(L,1)) GO TO 130
17     IF (CYCLE(L-1,2) .NE. CYCLE(L,2)) GO TO 130
18     L = L - 1
19     RNECYC(L) = RNECYC(L) + 1.0
20     LIND = 1
21     RETURN
22     END

```

SUBROUTINE DECRES(LRMAX,NCYNO)
COMMON/PCGDE/L,LIND
COMMON/DECRES(1400),INDEX(1400),IND1,IND2,IND3,IND4,KIND
THIS SUBROUTINE DECIDES WHETHER OR NOT THE ELEMENTS OF THE RESIDUE
SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS

K = 0
NCYNO = 0

X1 = RES(1)
X2 = RES(2)
X3 = RES(3)
X4 = RES(4)

IND1 = INDEX(1)
IND2 = INDEX(2)
IND3 = INDEX(3)
IND4 = INDEX(4)

J = 4

10 IF (X2 .GT. X1) GO TO 150
IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500
150 IF (X2 .GT. X3) GO TO 151
CALL CYCRES(X3,X2,1.0,IND3)
GO TO 152

151 CALL CYCRES(X2,X3,1.0,IND2)
152 NCYNO = NCYNO + 1

X1 = X1
X2 = X4

IND2 = IND4

IF (J .EQ. LRMAX) GO TO 300
IF (J + 1) .EQ. LRMAX) GO TO 315

X3 = RES(J+1)
X4 = RES(J+2)
IND3 = INDEX(J+1)
IND4 = INDEX(J+2)

J = J+2

GO TO 10
100 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500
GO TO 150

500 K = K + 1
RES(K) = X1
INDEX(K) = IND1
J = J + 1

IF (J .GT. LRMAX) GO TO 330

X1 = X2
X2 = X3
X3 = X4

X4 = RES(J)
IND1 = IND2
IND2 = IND3
IND3 = IND4

IND4 = INDEX(J)
GO TO 10
300 K = K + 1
RES(K) = X1
RES(K+1) = X2

SUBROUTINE DEGRES TRACE

```

60      INDEX(K) = IND1
        INDEX(K+1) = IND2
        LRMAX = K + 1
        RETURN
315     K = K + 1
        RES(K) = X1
        RES(K+1) = X2
        RES(K+2) = RES(J+1)
        INDEX(K) = IND1
65      INDEX(K+1) = IND2
        INDEX(K+2) = INDEX(J+1)
        LRMAX = K + 2
        RETURN
330     K = K + 1
        RES(K) = X2
        RES(K+1) = X3
        RES(K+2) = X4
        INDEX(K) = IND2
75      INDEX(K+1) = IND3
        INDEX(K+2) = IND4
        LRMAX = K + 2
        RETURN
        END

```

SUBROUTINE CYCRES TRACE

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SUBROUTINE CYCRES(Y1,Y2, CYCZF,NSTEPP)
COMMON/MCYG/CYCLE(900,2),RNECYC(900),NNSTEP(900)
COMMON/MCGOE/L,LIND

C
C
C
C

5 THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DATA
SUPPLIED BY SUBROUTINE DECRES

10 L = L + 1
CYCLE(L,1) = Y1
CYCLE(L,2) = Y2
RNECYC(L) = CYCPF
NNSTEP(L) = NSTEPP
RETURN
END